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ROTIFERA WITHOUT ROTARY ORGANS.

BY PROF. JOSEPH LEIDY.

The Rotifera or Wheel-animalcules, form a small class, abundant in kind and found almost everywhere in association with Algæ, and with Infusorians to which they were formerly considered to belong. Later they have been recognized as not having the simple cell structure of the latter, and for a time were regarded as pertaining to the Crustacea. They are now commonly looked upon as belonging to the group of Worms, but their relative position cannot yet be considered as positively determined. They generally possess a chitinous integument with a more or less annulate disposition or tendency to articulate division; but they are destitute of limbs. Some are provided with a carapace and recall crustacean forms, but in other points they exhibit but little likeness to them. Their usually striking characteristic, the rotary disks, from which they are named, is not possessed by any well-marked Crustacean. Among the Rotifera, however, there appear to be some which do not possess the rotary organs, at least in the mature condition, and yet in all other respects the animals conform in structure with ordinary forms.

Dujardin (Infusoires, 1841, 653, Pl. 22, fig. 2) was the first to describe a Rotifer destitute of rotary organs, to which he gave the name of *Lindia torulosa*. It is a free, swimming, worm-like, telescopic form, common in the class.

Gosse (Annals and Mag. of Nat. Hist., 1851, viii, 199) described an allied form, without rotary organs, under the name of *Taphrocampa annulosa*.

Cohn (Zeits. f. wissens. Zoologie, 1858, 287, Taf. xiii, fig. 1, 2) described a Rotifer resembling *Lindia*, but possessing rotary organs. He supposes it to be the same; and suspects that in the animal observed by Dujardin, the rotary disks had been withdrawn, in a manner common to the class. He remarks that the existence of a Rotifer, without vibratile cilia, would be a rude abnormity in the class, the more so because the possession of cilia is the most important character which separates the Rotifers from the Crustaceans.

In a marginal note I find that some years ago, at Newport,

R. I., I observed a Rotifer apparently devoid of rotary organs, which I took to be the *Lindia* of Dujardin.

However, even previously to Cohn's communication (see these Proceedings, 1857, 204), I described an animal which I regarded as a Rotifer, without doubt entirely destitute of the characteristic rotary organs or any trace whatever of vibratile cilia. It was named *Dictyophora vorax;* and it is quite different in form from the preceding animals. It is spheroidal, inarticulate, without carapace, or jointed tail; and possesses a large protractile and retractile pouch or cup, as a substitute for the ordinary rotary disks. It is attached to fixed objects, and has been observed on several occasions adherent to stones and the glass of an aquarium. The description of the animal, unaccompanied by illustration, seems never to have attracted attention.

Some years subsequently, Meczinchow (Zeits. f. wis. Zoologie, 1866, 346, Taf. xix) described a similar Rotifer to mine, under the name of *Apsilus lentiformis.* It was found, at Giessen, attached to the leaves of *Nymphæa lutea.* It is larger than *Dictyophora*, and differs mainly in the possession of bristled tentacles (" Gefühlorgane ") and a ganglion to the pouch, neither of which were observed by me in *Dictyophora.*

The following year, Claparede (An. d. Sc. Nat., 1867, viii, 12, Pl. 4, figs. 3, 4) described another Rotifer, without the characteristic organs, under the name of *Balatro calvus.* It resembles the earlier described forms, and was observed to be parasitic on worms, in the River Seime, Canton of Geneva.

A short time since, Mr. S. A. Forbes (Am. Month. Micros. Jour., 1882, 102, 151), of Normal, Illinois, described a Rotifer, destitute of rotary disks, with the name of *Cupelopagus bucinedax.* It was found attached to the glass of an aquarium, and it appears to me to be so nearly like *Dictyophora vorax*, that I suspect it to be the same.

More recently, while examining some *Plumatella diffusa* from the Schuylkill River, below Fairmount dam, my attention was attracted to several groups of *Megalotrocha alba*, attached to the tubes of the former, and surrounding another animal of strange and novel character. This on examination proved to be another remarkable Rotifer, without rotary organs, and it is the interest which attaches to this discovery which has led to the present communication. As with many analagous things, I had not the leisure to give it due study, and yet I felt that if I reserved it for future investigation, I might never meet with a more favorable opportunity for the purpose.

The new Rotifer I propose to name *Acyclus inquietus*, from its being destitute of wheels, or ciliated disks, and from its apparently restless habit. It is considerably larger than *Megalotrocha*, measures nearly a half line long, and can readily be distinguished, in groups of the latter, with the naked eye. It was observed in eight instances, in each, alone and always enclosed in a group of the *Megalotrocha*, above which, from its greater size, it towered like a giant in a crowd. In its constitution, for the most part it resembles *Megalotrocha*, and is attached in the same manner. In its movements it bends rather abruptly in different directions and curves downward so as to bring its prehensile mouth on a level with the currents produced by the rotary disks of the surrounding Megalotrochæ. Sometimes alone or in company with the latter, it suddenly contracts and then more slowly elongates and resumes its bending motions, scarcely for a moment appearing in an erect attitude. Occasionally it will even double on itself to such a degree that the extremities are approximated, or as the motion is commonly expressed, the head nearly touches the end of the tail or point of attachment. The movements of the creature recalled to me those of the avicularia of some of the marine Polyzoa, or of the pedicellaria of Echini.

At one time I had the opportunity of seeing an individual of *Plumatella* with outspread arms, and in its immediate vicinity a group of Megalotrochæ with open disks and an *Acyclus* in its midst, together with two worms of the genus *Dero*, with extended and expanded branchial tails, all acting together in concert, apparently perfectly regardless of the presence of one another—messmates partaking of the same repast.

Acyclus is translucent whitish with the thicker part of the body yellowish or brownish, due to the color of the capacious intestine shining through the integument. It was difficult to obtain a clear and accurate view of the exact mode of attachment and the internal structure of the animal, from its incessant motions, its becoming wrinkled in contraction, and from its being obscured by the surrounding bunch of Megalotrochæ. In the attempt to remove these, the *Acyclus* was detached and then would contract to such a degree, that nothing could be determined as to the arrangement of its organs. Under the circumstances the accompanying figure 1, Plate II, of the animal, is to be regarded as only approximately correct. Most of the individuals seen were naked, like *Megalotrocha*, but had adherent a profusion of eggs. In two instances the animal was included in a copious colorless gelatinous sheath, as represented in the figure, but had also adherent a large bunch of eggs, in one of which bunches I counted upwards of fifty.

The head of *Acyclus* substitutes the rotary disk of the *Megalotrocha* and other Rotifers provided with this organ. It is in the form of a cup prolonged at the mouth into an incurved beak, as represented in figures 1–4. It is retractile and protrusile, contractile and expansile. When protruded and expanded the mouth gapes widely, and the beak becomes more extended, but always remains incurved. The mouth is bordered by a delicate membrane extending to the rounded end of the beak and presenting a festooned appearance. In contraction of the mouth the marginal membrane becomes inflected, the orifice constricted, and the beak more incurved. In contraction of the head or oral cup, it is reduced to half the bulk of its expanded condition, while the mouth is constricted and the beak is rolled in a single spiral inwardly as seen in figures 2, 3.

The extension of the head below forms a narrowed and transversely wrinkled neck which expands into the body. The expansion and contraction of the head appear to be due to the flow of a milky liquid between the cœlum or body-cavity and intervals in the walls of the oral cup or head. The retraction of the latter is produced by longitudinal muscles, which may be seen in the wall of the cup extending from the wall of the body just below the neck to the festooned membrane bordering the mouth.

The movements of the mouth with the partial extension and involution of the beak, together with the general movement of the animal, were strongly suggestive of those of the proboscis of an elephant.

The oral cavity converges in a funnel-like manner to a pouch occupying the neck. The pouch is seen to contract and expand from time to time, but it was indistinctly defined. At the bottom of the pouch there is a small mastax or muscular pharynx provided with minute jaws. These parts were but indistinctly seen, and indeed the jaws could be detected only after compressing the animal and examining it with the $\frac{1}{10}$ objective glass of the microscope. The jaws are composed of a parallel series of about twenty teeth.

The body of the animal is fusiform or elliptical and narrows into a long tail, attached by the end. In contraction, the body and tail become more or less wrinkled transversely, as in *Megalotrocha.* The tail is occupied by retractor muscles extending from the walls of the body. The cavity of the latter is occupied by a capacious stomach, elliptical in shape and extending from the mastax to the root of the tail, but its mode of termination I did not detect. The anal aperture occupies a position near the latter, but its exact character I also failed to determine. The interval of the stomach and wall of the body is occupied by the ovaries and ova. In the vicinity of the lower extremity of the stomach there were several yellow spherical balls; a large one with concentric layers, and several small ones apparently of the same nature. The character of these I could not make out. An ovum was observed to be discharged in the vicinity of the anal aperture, but its outlet was not distinguished. The ova are large and oval, and exhibit no signs of segmentation at the time of extrusion.

The embryo, figs. 5, 6, developed in the egg exterior to the parent, at the time of its escape is a soft worm-like body, with a blunt head end and tapering behind to a rounded tail end in the dorsal view. The head end, not distinct from the body, is retractile; and the terminal mouth is furnished with vibratile cilia, which are also retractile. The posterior part of the body is indistinctly divided and is retractile in a telescopic manner. In the lateral view the tail end appears slightly notched or furcate, with one branch longer than the other. The head exhibits a pair of minute red eye-points, and a short distance behind, it presents a minute pointed papilla, with a still more minute bristle at the summit. The embryo swims and moves about very much in the manner of the common Rotifer, often adhering by the tail end, retracting head or tail and successively elongating.

The chief distinctive characters of the animal thus described are as follows:

Acyclus inquietus.

Body fusiform, tapering behind into a long narrow tail-like appendage, by which it is attached, not distinctly annulated, but becoming transversely wrinkled in contraction. A non-ciliated cup-like head prolonged into an incurved digitiform appendage (as a substitute for the usual trochal disk), contractile and retractile.

Length of the animal from 1·2 to 1·5 mm.; breadth of body 0·15 to 0·21 mm. Length of head, with moderate extension of the digitiform appendage, 0·216 to 0·27 mm.; breadth, 0·15 to 0·18 mm. Ova, 0·1 to 0·133 long, by 0·06 to 0·09 mm. broad. Embryo, 0·36 mm. long by 0·06 wide at the head end.

With the figures of *Acyclus*, for comparison with this and other Rotifers devoid of trochal disks which have been described, I have given one, fig. 7, of *Dictyophora*, drawn from observation of the animal some years subsequent to its discovery. The creature was attached to objects in, and to the inner surface of, an aquarium and could not be examined advantageously; and I had deferred my investigation of the animal to a more favorable opportunity. Under the circumstances the drawing must be viewed as only approximately correct. As previously indicated, the original description of *Dictyophora vorax* occurs in these Proceedings for 1857. Since then I have had several opportunities of observing it, and it appears readily to be introduced and reproduced in an aquarium with water and aquatic plants from the rivers of our vicinity.

Dictyophora is oval or ovoid, with the narrower pole, corresponding with the position of the mouth, truncated, and it adheres by a small disk or sucker to one side of the broader pole. The animal has the power of turning on its point of attachment, but whether it has the power of detaching itself at any time I did not ascertain, though the same individual appeared after some days not to have changed its position.

The body is transparent, colorless, and even, and exhibits no signs of annulation, nor does it become transversely wrinkled by contraction. The external chitinous wall presents an appearance of scattered granules or minute tubercles. The interior exhibits the digestive apparatus and other organs, mostly more or less obscured by an accumulation of eggs in various stages of development.

From the truncated extremity of the body, the animal projects a capacious delicate membranous cup, forming more than half a sphere and more than half the size of the body. At will the cup is entirely withdrawn into the body and the orifice of this becomes contracted and puckered into folds radiating from a central point or orifice. When protruded the cup expands outwardly like an opening umbrella, and when fully expanded equals the breadth of the body with more than half its depth. It is provided with an irregular reticulation of delicate muscles, mostly longitudinal and a few transverse, and scarcely distinguishable from wrinkles. Other muscles, acting as retractors, extend from the membranous cup to the inner wall of the body of the animal. The cup or net substitutes the ordinary trochal disks of Rotifers and appears as a most efficient means in catching the animalcules which serve as food to *Dictyophora.*

The prehensile cup opens into a capacious sac which is within the body and occupies a good portion of its upper half. The sac at bottom communicates with a mastax nearly central in position. This is provided with a pair of jaws each consisting of a larger tooth and a vertical series of four smaller ones. The jaws are observed to be in frequent motion, as usual in Rotifers.

The mastax opens into a capacious sacculated stomach of a brownish or yellowish color. The outlines of the different portions of the alimentary apparatus are difficult to make out from their being more or less obscured by the ova with embryos contiguous to them. Muscular fibres pass from the viscera to the outer wall of the cœlum, or body-cavity. Adherent to this wall there are situated at different points whitish bodies, similar to those seen in other animals of the class, the nature of which is unknown.

Numerous ova, in all conditions from the earliest to those which contain fully developed embryos, occupy the body-cavity of *Dictyophora*, sometimes in such numbers as to obscure everything else from view.

Various specimens of *Dictyophora* with extended cup measured from 0·6 to 1 mm. in length. Closed specimens from 0·35 to 0·6 mm. long by 0·28 to 0·5 mm. broad. Ordinarily the body measured from 0·45 to 0·6 mm. long by 0·35 to 0·5 mm. broad. The cup in several ranged from 0·26 to 0·5 mm. both in height and breadth.

The animal is exceedingly sensitive, and with the slightest disturbance withdraws its net. It feeds especially on smaller animalcules, and in one instance upwards of fifty of these were squeezed from the stomach.

From *Apsilus lentiformis*, which *Dictyophora* closely resembles, it differs especially in the absence of the lateral antennæ, and the conspicuous ganglion of the cephalic cup.

While *Lindia*, *Taphrocampa* and *Balatro* may be open to the suspicion of possessing ciliary rotiform disks, which perhaps were concealed when the animals were observed, the same cannot be the case with *Dictyophora*, *Apsilus* and *Acyclus*.

As remarked by Mr. Forbes, the former name had been preoccupied; and thus if the *Cupelopagus* should prove to be the same, this name may properly supply its place.

REFERENCES TO PLATE II.

Figs. 1-6. *Acyclus inquietus.*

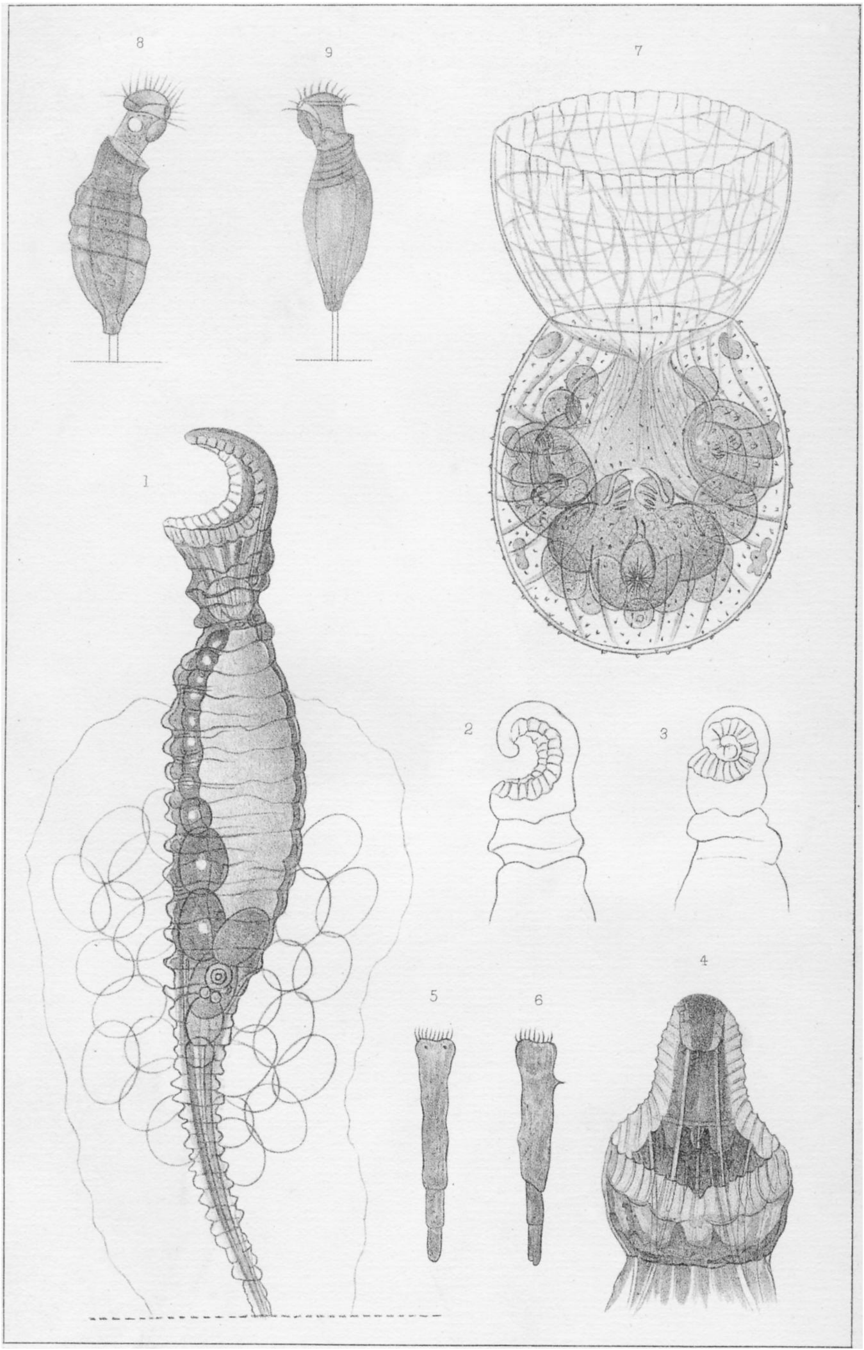
Fig. 1. The animal extended, enclosed with eggs, in a gelatinous sheath. Magnified 96 diameters.

Figs. 2, 3. Different degrees of contraction of the head-cup. Magnified 96 diameters.

Fig. 4. Anterior view of the head-cup. Magnified 166 diameters.

Figs. 5, 6. Front and side view of the embryo. Magnified 80 diameters.

Fig. 7. *Dictyophora vorax.* Animal with its head-cup extended. Magnified 75 diameters.



Jos. Leidy, M.D. del.

1-6. ACYCLUS INQUIETUS. 7. DICTYOPHORA VORAX
8-9. PYXICOLA ANNULATA.